Project Approach

1. Network Design and Topology

The network topology designed for this simulation is reflective of **PowerGrid's telecom backbone network** in terms of functionality, though simplified for the scope of the project. The topology is based on the use of **BGP** (Border Gateway Protocol) for inter-domain (external) routing and **OSPF** (Open Shortest Path First) for internal (intra-domain) routing.

The simulated topology consists of **6 routers**, which are organized as follows:

- **Edge Routers** (R1, R2): These routers represent the **boundary** between the internal network (within an **Autonomous System (AS)**) and external networks. **BGP peering** is configured between R1 and R3 (AS 65001 ↔ AS 65010) and between R2 and R6 (AS 65002 ↔ AS 65020).

- **Core Routers** (R3, R4, R5, R6): These routers are connected through **OSPF**, representing the **internal backbone network**. The routing protocol in this region is **OSPF** to ensure fast convergence and **dynamic routing**.

Topology Layout:

- **R1 ↔ R3 (BGP)**: Represents the inter-AS communication where **R1** (AS 65001) communicates with **R3** (AS 65010).

- **R2 ↔ R6 (BGP)**: Similarly, **R2** (AS 65002) peers with **R6** (AS 65020) to exchange routing information.

- **R3 ↔ R4 ↔ R5 ↔ R6 (OSPF)**: The core routers are interconnected using **OSPF**, ensuring that routing within the internal AS is efficiently handled with fast convergence and no routing loops.

The routers in the topology represent key components of a **telecom backbone network**: the edge routers manage inter-AS traffic via **BGP**, while the core routers handle internal routing through **OSPF**. Additionally, internal links between core routers are **redundant**, ensuring that network traffic remains uninterrupted in the event of a failure.

2. IP Addressing and Subnetting

For **IP addressing** and **subnetting**, a structured plan was followed:

- **Router IP Addresses**: Each router's interfaces were assigned **IP addresses** from a pre-defined **addressing scheme**. For example, **R1's internal network** might be assigned **10.1.1.0/24**, **R2's** could be **10.2.1.0/24**, and so on.
- **Subnetting**: Subnetting was applied to ensure the efficient use of IP addresses. For instance, **point-to-point links** were assigned **/30 subnets**, which provided only two usable IP addresses per connection, ideal for router-to-router communication.
- Subnet Masking: Masks like 255.255.255.252 were used for serial point-to-point connections to create very small subnets.

MAC Address are used by **Layer 2 switches** for directing frames to their correct destinations within a local network. In this simulation, **Cisco Packet Tracer** automatically assigns **unique MAC addresses** to each router's interface. These addresses are crucial for **Layer 2 switching** and ensuring data reaches the correct destination in the network.

3. Device Configuration

Configuring BGP Peering (R1 ↔ R3 and R2 ↔ R6):

The first step was to establish **BGP peering** between the **edge routers** (R1 ↔ R3 and R2 ↔ R6). BGP, being an **inter-domain routing protocol**, allows these routers to exchange **network information** with each other.

- **Start BGP Process**: On each router (R1, R3, R2, and R6), the **BGP process** was initiated using the command router bgp <AS_number>.
  Example for **R1** (AS 65001): router bgp 65001

- **Define Neighbors**: **BGP neighbors** were defined for each connection:
  R1 ↔ R3: On **R1**, configure **R3** (AS 65010) as the BGP neighbor.
  R2 ↔ R6: Similarly, on **R2**, configure **R6** (AS 65020) as the BGP neighbor.
  Example for R1: neighbor 192.168.1.2 remote-as 65010

- **Advertise Networks**: BGP needs to advertise the networks that are directly connected to each router. For **R1**, the **10.1.1.0/24** network was advertised to **R3**:
  network 10.1.1.0 mask 255.255.255.0

- **Verify Peering**: The **BGP peering status** was verified with the following commands:
  show ip bgp summary: This command helps in verifying if the BGP session has been established and the number of routes received.

  show ip route bgp: Verifies if the **BGP routes** are being successfully advertised.

The same process was repeated for **R2 ↔ R6**, where **R2** advertised its **10.2.1.0/24** network to **R6**.

Configuring OSPF (R3 ↔ R6)

With **BGP** handling inter-AS routing, **OSPF** was configured for routing within the internal network, specifically among the core routers (R3, R4, R5, and R6).

- **Start OSPF Process**: On each router (R3, R4, R5, and R6), **OSPF process** was initiated:

```
router ospf 1
```

- **Define Network Statements**: Routers must advertise their internal interfaces. For **R3**, networks such as **10.3.1.0/24** and the **point-to-point links** like **192.168.1.0/30** (between R1 and R3) were advertised.

```
network 192.168.1.0 0.0.0.3 area 0
network 10.3.1.0 0.0.0.255 area 0
```

- **OSPF Area Configuration**: All routers were placed into **Area 0**, which is the backbone area of OSPF, ensuring a simplified network design.

- **Verify OSPF Neighbors**: To confirm the **OSPF adjacency** between routers,

```
show ip ospf neighbor
show ip route ospf
```

the commands was used to verify that the routing tables were populated with the correct OSPF routes.

4. Traffic Generation and Simulation

Simulation of Traffic: After configuring the routers and establishing connectivity, traffic generation tests were conducted to simulate real network activity:

- **Ping Tests**: Standard **ping** tests were conducted between different PCs and routers to ensure that all parts of the network could communicate properly. For instance, **PC1** (connected to **R1**) was pinged from **PC2** (connected to **R2**) and vice versa to confirm inter-router connectivity.

  From PC1 to PC2: ping 10.2.1.2

- **Routing Table Checks**: Each router's **routing table** was reviewed using show ip route to ensure that the expected **BGP** and **OSPF routes** were present and propagated correctly across the network.

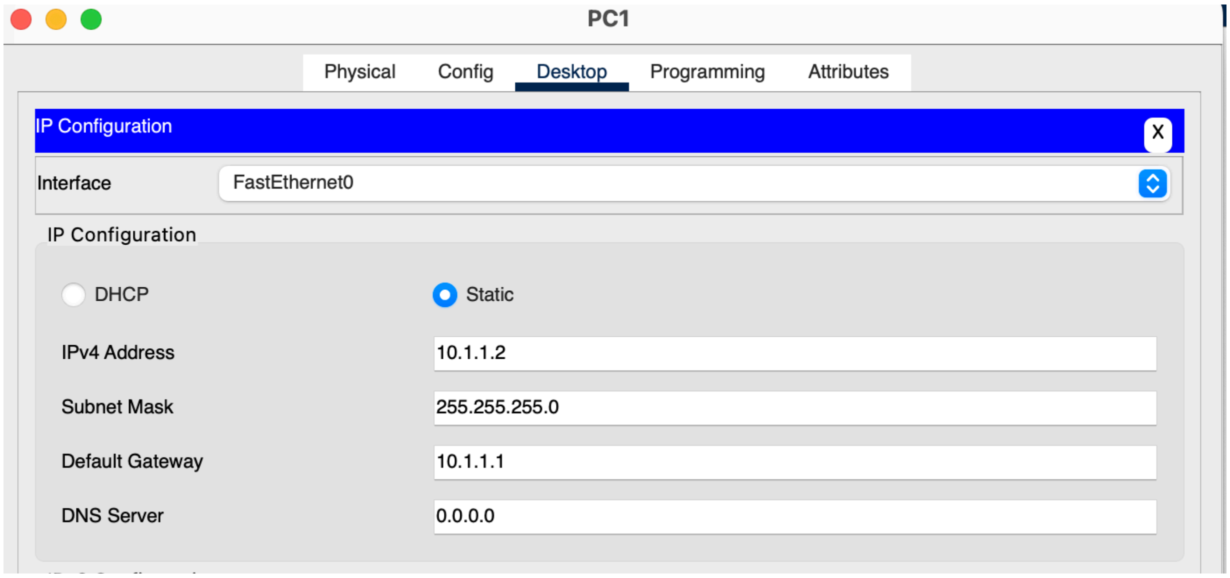

Fig 1. PC1 IP addressing

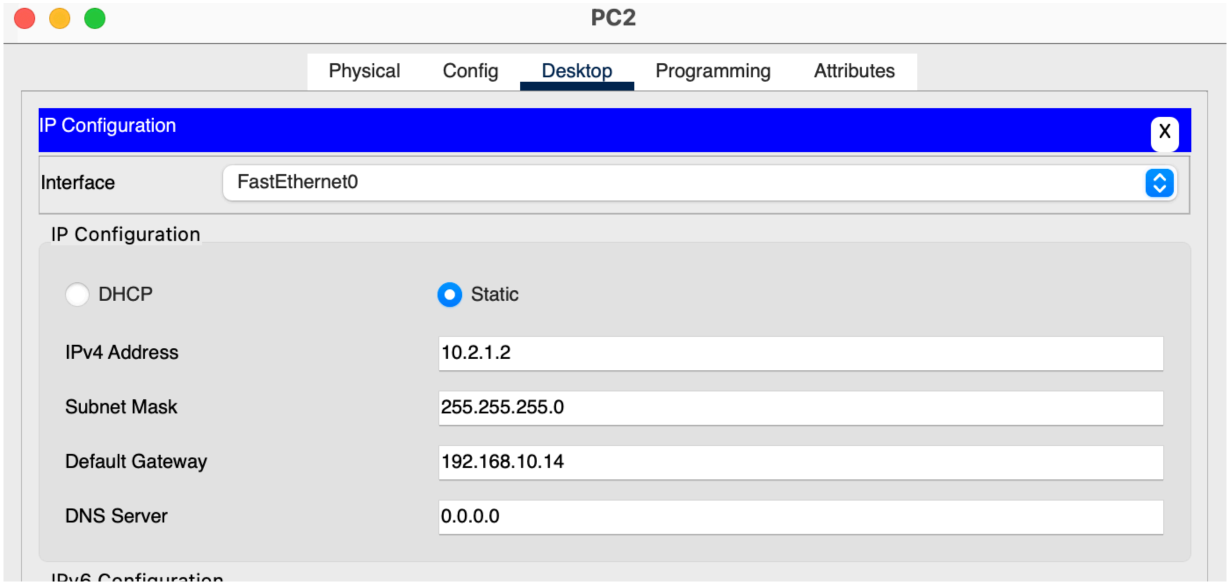

Fig 2. PC2 IP addressing

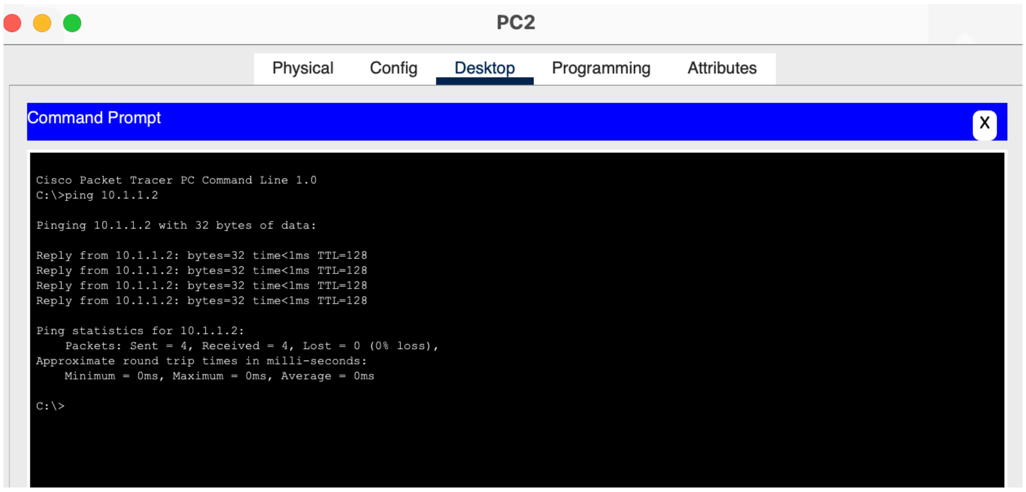

Fig 3. ping test from PC2 to PC1